MONTANA FISH AND GAME DEPARTMENT
Fisheries Division
HELENA, MONTANA

STREAM IMPROVEMENT TO INCREASE CUTTHROAT SPAWNING RUNS[1/]

Joe E. Huston
February, 1964

Introduction

Research conducted on the fishery of Hungry Horse Reservoir has indicated that one of the limiting factors governing the abundance of cutthroat trout (Salmo clarki clarki) is the amount of annual recruitment to the lake population. It is thought that this recruitment is from two principal sources; the South Fork of the Flathead River drainage above the reservoir and from streams that flow directly into the reservoir. To what magnitude these two general areas contribute young fish is not known.

A survey of the direct tributary stream conducted in 1960 indicated that many of the most desirable spawning streams or potential spawning streams were blocked to adult lake cutthroat by natural or man-made barriers. The man-made barriers were either road culverts or log jams.

Of the 48 continuous-flow streams that enter the reservoir 22 were judged capable of sustaining a notable cutthroat spawning population from the reservoir. Of these 22 streams, 10 did not have barriers, 2 had culverts that acted as partial barriers, and the remaining had either or both culvert or debris barriers. Table 1 lists the streams and their locations are shown in Figure 1.

The Montana Fish and Game Department, the Bureau of Reclamation, and the U. S. Forest Service have been aware of the fish passage problems created by the improperly placed culverts since the completion of Hungry Horse Reservoir in 1952. In 1954 the Bureau of Reclamation placed treated wood baffles in the culverts in Riverside, Harris, Felix, and North Fork Logan Creeks. Follow-up surveys by the Fish and Game Department showed that these baffles made the culverts passable for fish during the summer. No checks were made of the effect during the period of migration of the adult cutthroat spawners. Subsequent observations have shown these baffles do not allow passage of cutthroat spawners. They therefore must be considered inadequate.

The Hungry Horse Reservoir cutthroat generally spawn for the first time at four years of age and a length of 14 to 15 inches. Spawning time will vary each year depending upon water temperatures, but generally starts near mid-May and extends through mid-July. This period extends from just prior to high water to past peak stream run-off periods. The cutthroat spawning occurs at the worst possible time with respect to both passage through culverts and modification of culverts to facilitate passage.

1/ This work was undertaken as a part of Hungry Horse Reservoir Research and Management Project, 29-E-2.

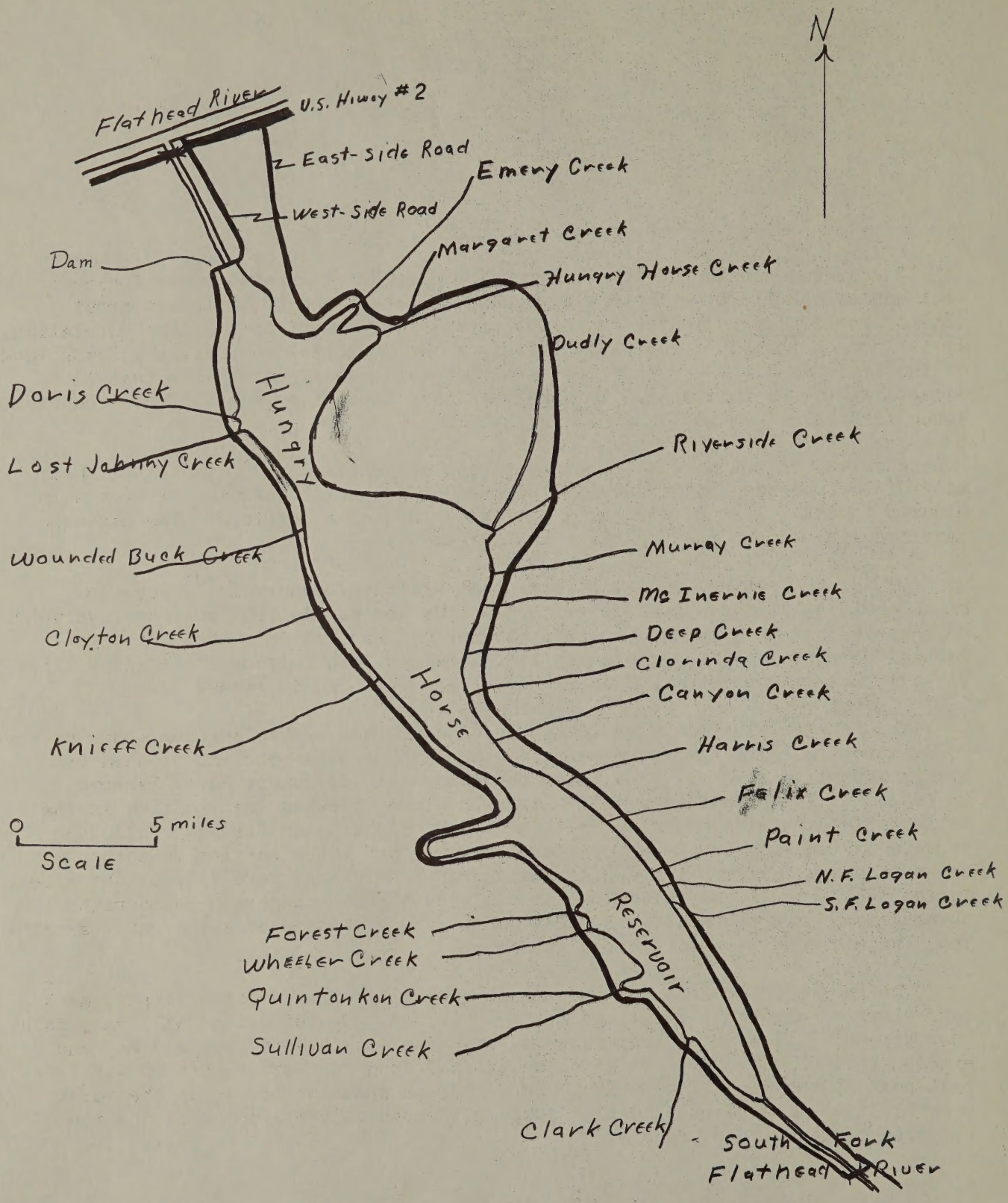

Figure 1. Hungry Horse Reservoir and Tributary Streams

Table 1. List of suitable cutthroat spawning creeks and absence or presence of barriers, 1960 survey.

Creek / Tributary Creek	FISH PASSAGE			TYPE BARRIER		
	Open	Partial	None	Debris	Culvert	Partial Culvert
Doris			X	X		X
Lost Johnny			X		X	
Wounded Buck			X		X	
Knieff	X					
Forest	X					
Wheeler	X					
Sullivan	X					
Quintonkon			X	X		
Clark	X					
So. Fk. Logan	X					
No. Fk. Logan			X		X	
Paint			X		X	
Felix			X		X	
Harris			X		X	
Canyon	X					
Clorinda			X		X	
Deep			X		X	
McInernie		X		X		X
Murray		X		X		
Dudley	X					
Riverside			X		X	
Hungry Horse	X					
Margaret		X				X
Lost Margaret		X				X
Emery	X					

The problem of fish passage through culverts in the Hungry Horse area is two-fold: (1), water velocities within the culvert and (2), falls at the lower end of the culvert. Falls at the lower lip of the culverts range from ½ foot to 3 feet while velocities vary from 3 or 4 feet to over 15 feet per second. These velocities occur in culverts varying from 55 to 120 feet long.

Fish Passage Repair and Evaluation

In 1961 and as a continuing program the Forest Service and the Fish and Game Department joined in an action program to correct as many of the fish passage problems as possible. The department also initiated studies to collect information about spawning cutthroat, the effects of a partial barrier upon a cutthroat run, and to evaluate the effectiveness of the fish passage improvement program.

The passage repair falls into two catagories: channel clearance and culvert repair.

Channel clearance involves the removal of logging debris, log jams, or other

debris from stream channels. The following streams were improved by this method:

Emery Creek---Emery Creek is one of the most important cutthroat spawning streams entering the reservoir from the east. Although fish-proof barriers were not present in this stream two log jams existed that could easily become so. These two obstacles were removed in the fall of 1963.

Quintonkon Creek---The Sullivan Creek drainage of which Quintonkon Creek is a major tributary is probably the most important lake cutthroat spawning area other than the South Fork of the Flathead River. All four species of game fish found in the reservoir spawn in this drainage. These four fish are: cutthroat trout, grayling (Thymallus arcticus), Dolly Varden(Salvelinus malma), and whitefish (Prosopium williamsoni).

A fish-proof log jam was present near the mouth of Quintonkon Creek. This obstacle was removed in the summer of 1962, opening up 10 to 15 miles of good spawning area. Surveys have not been made yet to determine the use of this new area by lake fish. Prior to its removal Dolly Varden, cutthroat, and whitefish were observed spawning in the area below the log jam. From this it might be assumed that fish would move into the new area.

Clayton Creek---Clayton Creek is a small tributary joining the reservoir from the west. This stream was not considered a spawning stream or potential spawning stream when the 1960 survey was made. All but the first ½ mile of stream was blocked by natural falls and this ½ mile was badly restricted by debris. Forest Service personnel observed that spawning cutthroat were attempting to enter this stream and they cleared the debris from this ½ mile in the summer of 1963.

Culvert Modification

The correction of culvert barriers is more difficult than the more-or-less manual job of stream-bed debris removal. Modification of culverts involves reduction of velocities within the culverts, elimination of outlet falls, or both.

The Forest Service estimated it cost a minimum of $1500 per culvert to install baffling to reduce velocities. Then too, baffles had not solved the problem. It had been observed that if cutthroat could get into a culvert they had a chance to swim the culvert even in the face of relatively high velocities. It was therefore decided to eliminate the outlet falls. This was to be accomplished by raising the water level of the pool below the culvert to just below, equal, or above the lower lip of the culvert. The work done on each stream will be described.

Doris Creek---Doris Creek enters Hungry Horse Reservoir from the west and is the first stream up from the dam. Two problems involving fish passage were present in this stream: debris in the channel from a timber "blow-down" and a partial-barrier culvert. In 1961 the Forest Service cleared the debris from the stream and built a small check dam a short distance below the culvert to eliminate about a six-inch falls. The dam consisted of a number of large boulders placed across the stream. The boulders slowed down water velocities with the result that stream-carried gravel was deposited and sealed the dam.

The success of these measures has been excellent. Spawning lake cutthroat have been found in this stream each spring since 1962. Tags from adult cutthroat tagged in the reservoir proper have been returned from Doris Creek. The data indicate that the repair work was a complete success with fish movement possible under all flow conditions.

No estimate of total spawning use has been made, but it is thought that several hundred cutthroat use the stream for spawning each year.

Lost Johnny Creek---Lost Johnny enters the reservoir from the west and is the second stream up from the dam. Fish passage was blocked by a 2-foot high falls and velocities greater than 10 feet per second. Volumes passing down the stream during spawning season varies from 100 to 400 cfs. The stream offers only about one mile of spawning area; the remainder being blocked by a natural falls.

A check dam consisting of rock and earth was built below the culvert raising the lower pool elevation to about the lower lip of the culvert during high water. A small spillway was left to allow fish movement into and out of the created pool. The work was completed in July, 1963 before the completion of that spring's cutthroat runs.

Forest Service personnel reported that some cutthroat were able to pass through the culvert immediately following the repair work. An evaluation in 1963 showed that during peak run-off cutthroat were still not able to pass through the culvert, but that fish could pass during non-peak flow conditions. It was estimated from fish and redd counts that 75 to 100 fish entered the stream and used the stream up to the base of the falls.

Wounded Buck Creek---Wounded Buck Creek enters the reservoir from the west and is the third stream up from the dam. Surveys of the streams blocked with culverts indicate that this one had most potential as a spawning stream. Large numbers of cutthroat, up to 500 at one time, had been observed trying to enter the stream.

Fish passage was blocked by high velocities within the culvert and about an 18-inch falls. Volumes passing through the culvert during spawning season varies from 200 to 500 cfs. Repair work consisted of placing several large boulders and much smaller rock below the culvert to raise the stream level to just below the lip of the culvert during high water. The work was completed after the 1962 spawning season.

An evaluation was made in 1963 and it was determined that cutthroat could pass through the culvert at all times except during the peak-flow periods. Spawning fish were found throughout the first five miles of stream. Whether this is the extent of their movement upstream is not known since the survey did not reach farther. It was estimated from fish and redd counts that between 300 and 500 fish used the five miles.

Both Lost Johnny and Wounded Buck are streams with extremely high peak flows. Under peak flow conditions the high velocities create such a head of water through the culvert that fish movement into the culvert is restricted. It was felt that if further means could be used to ease the way into the culvert during the peak flow periods, passage through the culvert would be realized. Part or all of this problem might be cured by further raising the lower pool elevation above the lip of the culvert, thereby pushing the lower pool into the culvert a short distance.

Raising the pool to a higher level would increase the danger of bank erosion and reduce the culvert's ability to handle large volumes of water. With due consideration of all problems involved, the Forest Service raised the elevation of Wounded Buck Creek in 1963. The effectiveness of this move will be determined in 1964 and further recommendations made for Lost Johnny Creek.

In conclusion it can be said that the repair work to date on Doris, Lost Johnny, and Wounded Buck Creeks has opened new areas to spawning cutthroat and should contribute much to the fish population of the reservoir.

Because of the success of the more-or-less experimental phase of the culvert repair program in the three west-side streams in 1961 and 1962, culvert repair was undertaken in four east-side streams in the fall of 1963. This latter repair work was done on a cost-share basis by the department and the Forest Service. The west-side repair had been initiated and financed by the Forest Service alone.

Stream flows and peak volumes for the east-side streams are less and occur at a more favorable time in relationship to the cutthroat spawning than in west-side streams. Peak flows usually occur prior to or during the early part of the east-side spawning season whereas they occur almost simultaneously with the peak of the run in west-side streams.

The four east-side streams repaired were North Fork Logan, Harris, Murray, and Lost Mare Creeks. Barriers to be repaired were falls in Lost Mare, Murray and North Fork Logan Creeks, and falls and culvert gradient in Harris Creek. The Murray and Lost Mare culverts were only partial barriers.

Each of the repairs consisted of raising the lower stream elevation up above the lower lip of the culvert, thereby pushing the pool back into the culvert a short distance. Rock and earth-filled gabions were used to create these pools. The gabions were dug down into the stream bed from 12 to 18 inches to insure stability as well as being anchored to the stream banks. A stair-step spillway was built to allow fish passage into and out of the gabion created pool.

The evaluation of these four projects will be done in the spring of 1964. It is anticipated they will be successful.

Culverts and Spawning Cutthroat

In conjunction with the culvert repair and channel clearance work the Montana Fish and Game Department ran an experiment to determine the effects of a partial-barrier culvert upon a spawning run of cutthroat. Margaret Creek, a tributary of Hungry Horse Creek(Figure 1) was chosen for this project. This small stream sustained a spawning run, had a partial barrier culvert, and was small enough to work adequately.

Fish traps were installed above and below the Margaret Creek culvert, (Figure 2). A thermograph was installed in the mouth of Hungry Horse Creek and stream volumes and velocity measurements within the culvert were taken periodically. The objective was to determine when and at what stream temperatures cutthroat entered the Hungry Horse Creek drainage, the total number of fish entering Margaret Creek, and the number passing through the culvert to continue up the creek. The conditions under which fish were able to pass through the

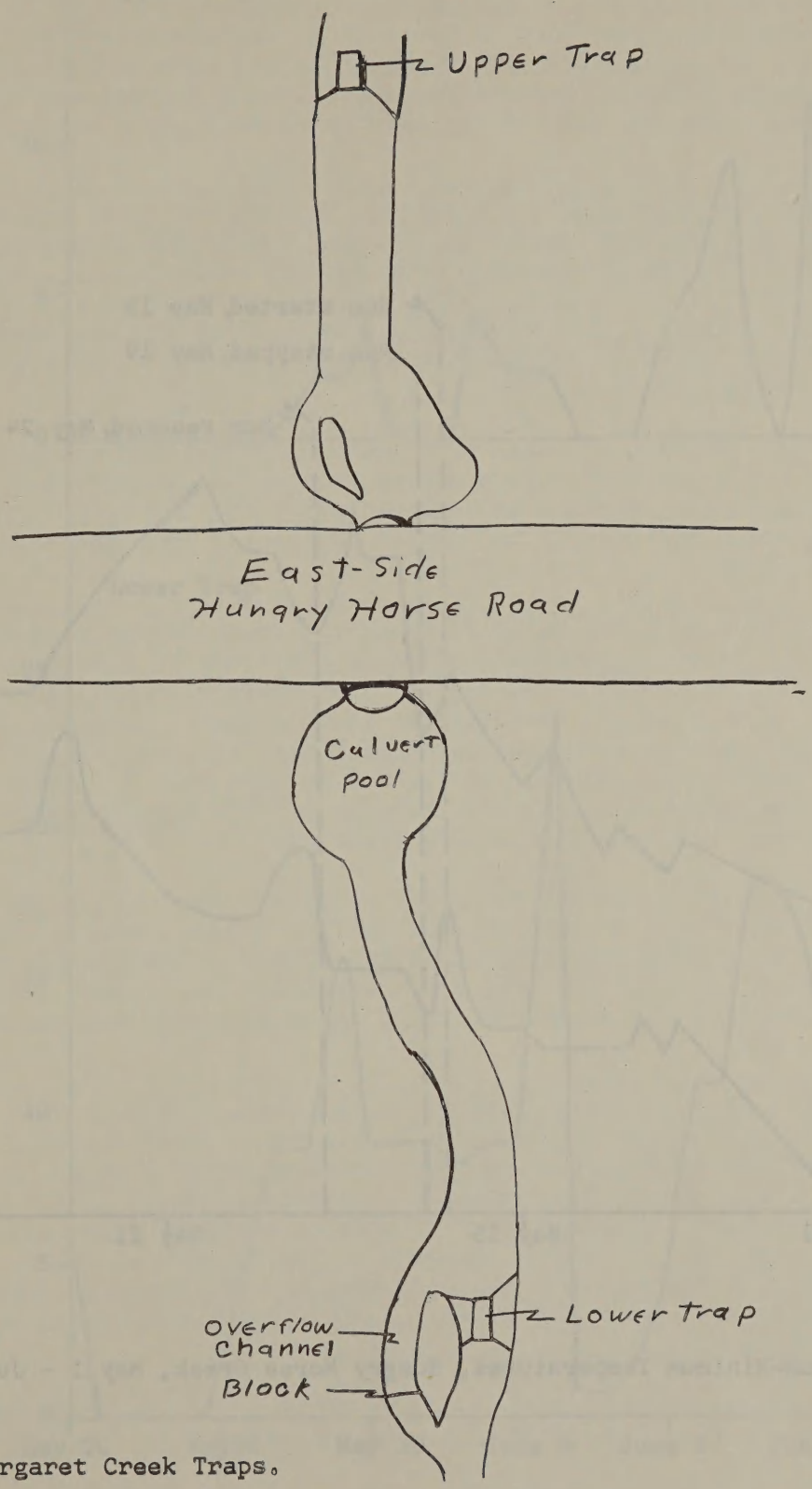

Figure 2. Margaret Creek Traps.

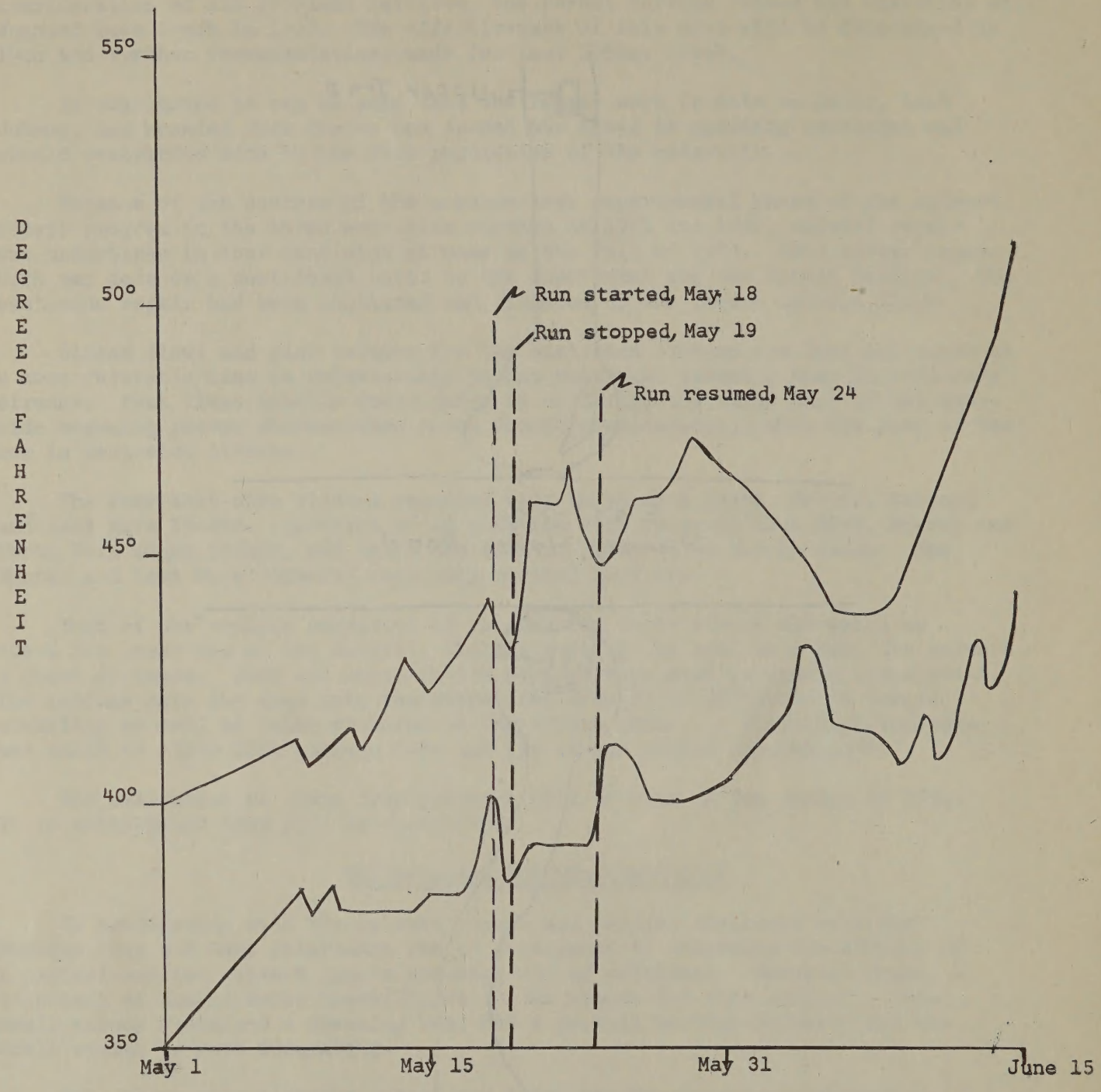

Figure 3. Maximum-Minimum Temperatures, Hungry Horse Creek, May 1 - June 15, 1964

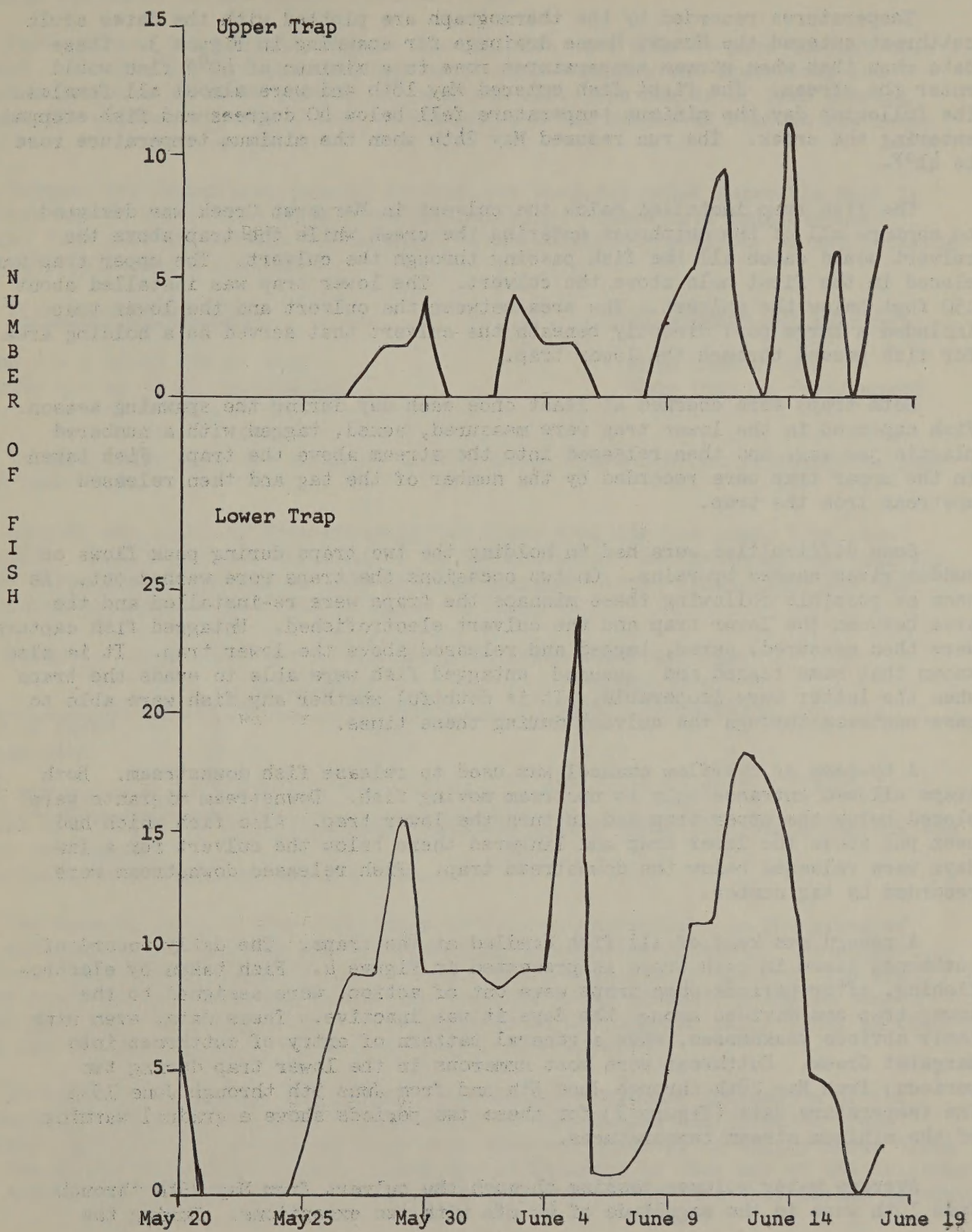

Figure 4. Number of fish entering Margaret Creek traps.

culvert were also studied.

Temperatures recorded by the thermograph are plotted with the dates adult cutthroat entered the Hungry Horse drainage for spawning in Figure 3. These data show that when stream temperatures rose to a minimum of 40°F fish would enter the stream. The first fish entered May 18th and were almost all females. The following day the minimum temperature fell below 40 degrees and fish stopped entering the creek. The run resumed May 24th when the minimum temperature rose to 41°F.

The fish trap installed below the culvert in Margaret Creek was designed to capture all of the cutthroat entering the creek while the trap above the culvert would catch all the fish passing through the culvert. The upper trap was placed in the first hole above the culvert. The lower trap was installed about 150 feet below the culvert. The area between the culvert and the lower trap included a large pool directly beneath the culvert that served as a holding area for fish passed through the lower trap.

Both traps were checked at least once each day during the spawning season. Fish captured in the lower trap were measured, sexed, tagged with a numbered plastic jaw tag, and then released into the stream above the trap. Fish taken in the upper trap were recorded by the number of the tag and then released upstream from the trap.

Some difficulties were had in holding the two traps during peak flows or sudden rises caused by rains. On two occasions the traps were washed out. As soon as possible following these mishaps the traps were re-installed and the area between the lower trap and the culvert electrofished. Untagged fish captured were then measured, sexed, tagged and released above the lower trap. It is also known that some tagged and assumed untagged fish were able to evade the traps when the latter were inoperable. It is doubtful whether any fish were able to pass upstream through the culvert during these times.

A by-pass or overflow channel was used to release fish downstream. Both traps allowed entrance only to upstream moving fish. Downstream migrants were placed below the upper trap and in turn the lower trap. Also fish which had been put above the lower trap and lingered there below the culvert for a few days were released below the downstream trap. Fish released downstream were recorded by tag number.

A record was kept of all fish handled at the traps. The daily record of cutthroat taken in both traps is presented in Figure 4. Fish taken by electrofishing, after periods when traps were out of action, were assigned to the lower trap and divided among the days it was inactive. These data, even with their obvious weaknesses, show a general pattern of entry of cutthroat into Margaret Creek. Cutthroat were most numerous in the lower trap during two periods: from May 28th through June 5th and from June 9th through June 15th. The temperature data (Figure 3) for these two periods shows a gradual warming of the minimum stream temperatures.

Average water volumes passing through the culvert from May 25th through June 10th were in the magnitude of 40 cfs with two exceptions. During the

periods of May 30th through June 3rd and from June 5th through June 8th rainy weather caused increases in stream flow of 10 to 20 cfs. After June 10th volumes steadily decreased to low summer flows of 5 cfs.

During these two periods of peak flow no fish were able to pass through the culvert. It also appears that the number of fish entering the lower trap is somewhat governed by these periods of peak run-off. The number of fish passing through the culvert appears to be correlated with the number of fish in the lower trap.

Volumes and velocities passing through the Margaret Creek culvert(4 feet in diameter and 56 feet long) were taken periodically. These data indicate that partial fish passage through the Margaret Creek culvert is possible or not possible under the following conditions:

Fish passage possible	Fish passage not possible
Volume - - - 40-45 cfs or less	More than 45 cfs
Velocity - - up to 11 feet/second	More than 11 feet/second

To gain entry into the Margaret Creek culvert the cutthroat first had to jump an 18 inch falls.

Lengths and sexes of fish entering the lower trap and the upper trap were recorded. These data give information on the makeup of the cutthroat run into the Hungry Horse Creek drainage as well as into Margaret Creek. These data for the fish entering each of the traps is given in Table 2.

Table 2. Length and sex of the Margaret Creek cutthroat run

	Lower Trap		Upper Trap	
	Males	Females	Males	Females
Number of fish*	67	123	29	33
Average size	16.0"	15.3"	15.9"	15.1"
Range	11.5-18.6	12.0 - 17.0	14.2 - 17.9	14.0 - 16.3
Grand Total**	215		64	

* Does not include 25 fish from lower trap and 2 from upper trap for which sex was not determined.

** Includes both sexed and unsexed fish.

The data in Table 2 show that there is no great difference in the sizes of fish entering Margaret Creek and those passing through the culvert. The culvert did block fish smaller than 14 inches long. There were few of these in the run. Of the cutthroat entering the lower trap only 64, or 30 percent, ascended the stream past the culvert barrier. Female cutthroat outnumbered males 1.8:1 in the total run but only 1.1:1 in those that passed the culvert.

Hook and line sampling and visual observations gave some indication of the movements of the fish that were unsuccessful in negotiating the Margaret Creek culvert. Several of these tagged fish were observed upstream in Hungry Horse Creek past the mouth of Margaret Creek. There are no indications that any of the "blocked" fish moved into other Hungry Horse Reservoir tributaries or that they failed to spawn.

Several fish entered the lower trap more than once during the study. As an example, two females averaging 15 inches first entered the trap May 28th and were released back downstream shortly thereafter. These same fish, still not spawned out, re-entered the trap June 15th and were successful in passing the culvert that same day.

To obtain a "guestimate" of the total spawning run into the Hungry Horse drainage a simple Petersen Index, using fish tagged below Margaret Creek compared to the total Margaret run and the tagged return, was tried. Thirty fish were tagged below Margaret Creek, of which seven were recovered in the lower trap. Computations for the estimate of the total Hungry Horse run are given below:

$$\frac{30(\text{Tagged in Hungry Horse Creek})}{7(\text{Return from lower trap})} = \frac{X(\text{Total run})}{215(\text{Margaret Creek run})}$$

$X = 921$ fish

It is realized that this estimate is extremely rough at best. In the author's opinion the estimate is low and the total run probably numbers between 1500 and 2000 fish.

Assuming that the 921 estimate is correct, that of these 921 fish 64 percent are females, and that an average 15-inch female will bear 1500 eggs, these 921 cutthroat are capable of laying down 883,500 eggs. Furthermore, assuming a two percent survival of eggs to a six-inch fish, the 921 adults are producing 17,670 young. With the annual continuation of the 921 adult run the remainder (17,670 - 921), 16,649, are available for the Montana angler. For the Montana hatchery system to replace these naturally produced fish would require an annual outlay of about $1450.

Using the same assumptions as used above, the 104 female cutthroat that were not able to pass through the Margaret Creek culvert would be capable of producing an additional 2905 six-inch fish for the angler. The value to produce this number of fish in the hatcheries would amount to about $264 annually.

Continuation of Projects

It is planned to intensify the research on cutthroat spawning populations using the Hungry Horse Creek drainage. Procedures will be to operate traps in Hungry Horse Creek as well as all of its tributaries. Cutthroat trout entering Hungry Horse Creek will be trapped, measured, sexed, tagged, and released upstream. As these fish move into the tributaries they will again be recorded. Their movement out of the spawning beds will be recorded. Information obtained from this program will include the following:

1. Age and growth rate of the spawners
2. Sex ratio of fish trapped
3. Fecundity of spawners
4. Distribution of spawners throughout the drainage
5. Number of adults returning to lake
6. Mortality rates; natural and angler
7. Use of the drainage by other fish species for spawning

8. Condition of stream during the spawning period of the various species
9. Number of juvenile fish returning to the lake
10. Time of, size of, and age of returning juvenile fish

Another year of measurements will also be collected from the Margaret Creek upper and lower traps. In the summer of 1964 this culvert will be repaired. After this repair it is planned to again enumerate the total usage of the Hungry Horse Creek drainage by cutthroat. It is conceivable that the removal of the Margaret Creek culvert barrier will increase the usage of the entire drainage by spawning fish.

In addition to the Hungry Horse Creek program the Forest Service and the Montana Fish and Game Department are making plans to repair additional culverts. Streams under consideration at this time include Riverside Creek, McInernie Creek, and Felix Creek. These repairs will not be done until evaluation has been made on Murray Creek, Harris Creek, and North Fork Logan Creek.